10/564514
JAP15 Rec'd PCT/PTO 13 JAN 2006

WELL AND METHOD FOR REGENERATING A WELL

The invention relates to a well for extracting, observing and/or lowering of ground water, comprising a standpipe having at least one filter pipe area and comprising at least one pump arranged in the standpipe. The invention further relates to a method for regenerating a well provided for extracting, observing and/or lowering of ground water.

Wells of the type specified initially have been known from practice for a long time. To produce a known well, a bore is initially sunk as far as the area of the water-bearing layer. The standpipe is then installed together with the lower filter pipe or filter pipe area. Filter gravel is then inserted in the annular space between the filter pipe area and the surrounding rock mass. The height of the filter gravel layer is determined according to the length of the filter pipe area or the thickness of the water-bearing layer. The annular space between the standpipe and the surrounding rock mass is then filled with a hydraulic binder which is generally a water-cement mixture. This hydraulic binder should substantially ensure that the position of the standpipe in the borehole is firm and stable and the standpipe is fixed to the rock mass. Finally, an underwater pump is inserted in the standpipe for pumping away the groundwater. The upper termination of the well is usually formed by a well head by which means the pumped ground water is supplied to its further intended usage.

The known wells described initially have various disadvantages. An important disadvantage of the known wells is that these frequently have only a comparatively short lifetime. This occurs because after a certain operating time, a filter cake is formed on the filter pipe area. At the same time, the fine pores and capillaries in the filter

gravel are clogged by particles in the ground water. This has the result that at constant pump power the quantity of water obtained per unit time decreases. In order to clean or regenerate the filter pipe area and the filter gravel surrounding said area, in some cases an attempt is made to carry out backflushing. This is not only expensive in terms of apparatus. Backflushing also has the result that particles are dissolved out from the filter cake, are pressed into the rock mass and thus impede the water inflow during the subsequent pumping.

If a well can no longer be sufficiently regenerated by means of backflushing, a new well needs to be produced since it is not possible to withdraw the old standpipe as a result of the firm connection to the surrounding rock mass. In any case, the underwater pump used so far can be re-used for the new well.

Another disadvantage of the known wells is that especially in the case of wells located in areas where agricultural usage is also taking place, elevated nitrate levels occur in the conveyed groundwater. In addition, other contamination such as salt water for example can adversely affect the ground water. This is obtained because when ground water is pumped from the relevant water-bearing layer, so-called foreign water, that is water from other layers, is also pumped.

It is thus the object of the present invention to provide a well of the type specified initially and a method for regenerating a well, where the well can be regenerated simply and cheaply.

The previously derived object is solved according to the invention in a well of the type specified initially by allocating to the filter pipe area a spraying device for spraying the filter pipe area and/or the well area adjacent

to the filter pipe area and connecting the spraying device to at least one pressure line for supplying the spraying unit with a medium to be sprayed. The invention offers a number of in some cases substantial advantages. Firstly, the invention makes it possible to increase the lifetime of a well quite considerably. The spraying device makes it possible to loosen any filter cake located on the filter pipe area and loosen the gravel layer surrounding the filter pipe area as adjacent well area to such an extent that particles blocking the pores and capillaries in the filter gravel layer are removed. The crucial factor is that by means of the spraying device, the medium can be supplied quite specifically on to the areas to be regenerated so pressing of particles into the water-bearing layer can be at least substantially avoided. Since the spraying device is completely independent of the pump of the well, the spraying and therefore regeneration of the well can also take place during pumping. As a result of the spraying, loosened particles and other contamination are immediately removed via the pump without clogging the surrounding rock mass. In addition, it is possible in the invention to supply a wide range of media to the spraying device through the pressure line which ends above ground. The supplied medium can be used both for regeneration, that is for cleaning the filter pipe area and the filter gravel bed and also for water treatment if gases such as ozone and/or liquid water treatment agents, in some cases with solid particles such as water with charcoal dust, are supplied to the spraying device by means of the pressure line.

In order to be able to regenerate the filter pipe region and the filter gravel layer adjacent thereto as far as possible over the entire circumference, the spraying unit has at least one annular channel affixed to the filter pipe region. This annular channel is provided with a plurality of nozzles distributed over its length via which the medium is supplied. The spacing of the individual nozzles is

preferably selected so that sufficient removal of the filter cake on the filter pipe region and adequate loosening of the filter gravel layer are easily achieved. In addition, in the case of a comparatively long filter pipe region, two or more annular channels can be provided which then have a sufficient spacing from one another in the axial direction to ensure sufficient regeneration of the entire lower well area.

In addition, it is understood that instead of an annular spraying means, a plurality of individual spraying points distributed over the circumference of the filter pipe area can naturally also be provided.

Good regeneration values i.e. dislodging the filter cake on the filter pipe area and loosening the adjacent filter gravel layer are preferably achieved by aligning some of the nozzles parallel to the pipe axis, preferably directly adjacent to the wall of the filter pipe area or at an acute angle thereto. A horizontal alignment of the nozzles is certainly possible. However, this can have the result that particles are pressed into the adjacent rock mass which can impair the ground water inflow.

In one embodiment of the invention it is provided that the nozzles are adjustable. An adjustment can be made for example by the nozzle being pivoted from a base position when pressure is applied to the spraying device depending on the pressure. At the same time, it is fundamentally also possible for the nozzles to rotate about an axis located on the ring circumferential axis when pressure is applied.

The nozzles can in principle be constructed as simple openings in the annular channel. However, in order to avoid clogging of the individual nozzles by particles and therefore encrustation or sintering, the nozzles have at least one valve and in particular a spring-loaded check

valve. The individual nozzle are hereby closed in the non-pressure-loaded state. The check valves only open at a predetermined minimum pressure obtained from the pressure loading of the spraying device in order to close again immediately after the end of the pressure loading. Finally, this ensure permanent and disturbance-free operation of the spraying device.

It has already been noted that the spraying device can have one or a plurality of annular channels depending on the length of the filter pipe area. If only one annular channel is required, it is possible for the spraying device to have a base plate connected to the annular channel which terminates the filter pipe area at the bottom. The spraying device or the annular channel thus form the lower end of the pipeline. In this embodiment the nozzles of the annular channel should not be directed downwards to avoid flushing out the soil at this point.

In order to ensure permanent operation of the spraying device according to the invention free from impairment, both the annular channel and also the pressure line supplying the medium should be made of plastic or stainless steel and should preferably be fixed to the standpipe on the outside. This outside fixing ultimately ensures that during withdrawal of the pump no contact can take place between the pump and the pressure line which could damage the pump and the pressure line.

It has already been mentioned initially that wells usually end on a wellhead located above ground which is also provided in the well according to the invention. According to the invention, it is now provided that an outlet is provided at the wellhead which communicates with the pump line of the pump. This outlet has a valve constructed such that the water pumped by the pump is not removed via the usual water drain pipe but exclusively via the outlet. The

outlet should have an associated drive by which means the outlet is automatically opening following or during spraying and the pumped water is removed without it being necessary to dismantle the wellhead, remove the pump or other measures.

Also associated with the well according to the invention is a supply device for supplying a liquid and/or gaseous medium to the spraying device. This supply device is connected to the pressure line at its above-ground end. The supply device is preferably constructed so that the medium is supply thereby to the spraying device either at constant pressure or by means of pressure surges. In order that the regeneration or water treatment result is not impaired by too high pressures or too strong pressure surges in this connection, the supply device has a pressure limiter so that certain maximum pressures cannot be exceeded. In addition, for automatic operation of the spraying device it is particularly suitable if the supply device has a time switch. By this means spraying can be carried out over a precisely predetermined time interval without an operator needing to monitor this. It is also favourable in this connection if the supply device is coupled to the outlet or its control so that depending on the spraying, water is automatically removed from the outlet for a predetermined time interval.

It was pointed out initially that in the known wells, the filter pipe area or the filter gravel layer cannot be regenerated sufficiently. To solve this problem it is provided in an alternative embodiment that the standpipe is located in an outer standpipe, that the outer standpipe is fixedly connected to the surrounding rock mass and that the standpipe is constructed as withdrawable from the outer standpipe. As a result, a double-pipe design of the well comprising an inner and an outer standpipe is obtained. Whereas the outer standpipe is fixedly connected to the

rock mass in an inherently known fashion, the inner standpipe on which the lower filter pipe area is located, can easily be withdrawn for above-ground regeneration which is not possible with conventional wells. In the embodiment according to the invention, the lower filter pipe area can be cleaned above ground after withdrawing the inner standpipe. The collapsed filter gravel is flushed out of the borehole itself which is held further open by means of the outer standpipe. The inner standpipe with the cleaned or a new filter pipe area can then be inserted into the outer standpipe again. The required quantity of filter gravel is then inserted into the annular space between the outer and the inner standpipe. The well can then be further operated again. Of particular advantage in this context is that the regeneration described previously can easily be carried out by the users of the well themselves and a suitable specialist company is thus not absolutely essential for carrying out the regeneration.

In addition, it is understood that the spraying device described initially specifically in connection with the double-pipe design of the well offers particular advantages since the possible withdrawal of the inner pipe only needs to be made very rarely. In this connection, the spraying device is then fixed to the inner pipe, namely on the filter pipe area in the manner described previously.

In order that the pumping is not impaired by the outer standpipe, the filter pipe area of the inner standpipe line projects downwards over the lower end of the outer standpipe. As a result, with the double-pipe design of the well it is thus the case that the outer standpipe extends as far as the respective water-bearing layer and thus stabilised the borehole from above ground as far as the water-bearing layer. In contrast, the inner pipeline with the filter pipe area penetrates into the water-bearing layer so that conveyance can be carried out by this means.

In order to facilitate both the insertion of the inner pipe into the outer pipe and the withdrawal therefrom and in order to also ensure a defined uniform annular space between the inner and the outer standpipe so that the requisite filter gravel can be brought into the area of the filter pipe region via this annular space, spacers are provided. These can be affixed to the inner and/or the outer standpipe.

In conjunction with the spraying device described initially, the pressure line should preferably be accommodated between two spacers which have a greater extension in the radial direction than the pressure pipe so that in this case the spacers have an additional protection function for the pressure line. It is understood that a plurality of corresponding spacers are provided distributed over the pipeline in the axial direction.

It was noted initially that a further disadvantage of the prior art is that in the known wells the conveyed water is frequently contaminated, for example, in the form of nitrate and/or salt water.

In order to extract non-contaminated ground water, the invention provides that the outer standpipe is sealed from the surrounding rock mass by means of a hydraulic mineral binder so that ground water is only obtained from the water-bearing layer in which the filter pipe area is located and an inflow of water from other layers is avoided. The invention differs from the prior art in that the hydraulic binders used in the prior art merely serve to fix the outer standpipe in the borehole. However, in known wells there is no sufficient sealing between the rock mass and the outer standpipe which results in an intake of contaminated external water via the inadequately sealed annular space between the outer standpipe and the adjacent

rock mass when the pump is operating. Since in the invention a seal is made between the outer standpipe and the rock mass, the original state of the rock mass is almost restored as it were. The water-bearing layer from which the water is obtained is sealed from other layers in the area of the annular space. A lowering funnel around the well, extending into other layers, as is usual in the prior art, is avoided in the invention. The fresh water obtained thus retains its original quality.

In addition, the present invention can be used not only for extracting ground water from one water level but also in several water levels. In this case, the outer standpipe or the standpipe line is divided and exposes the respective water-bearing layers. In each of the water-bearing layers, filter pipe areas are provided via which the ground water is obtained. Otherwise, the outer standpipe line is sealed in the manner described previously.

In connection with the present invention, it is especially favourable if the binder has a highly and permanently plastic behaviour when set, that is, it is extremely viscous. This ensures that especially in areas where earth movements occur, the well or the binder layer is not destroyed which can in turn result in an intake of contaminated external water.

A water/solid mixture based on marl has proved to be particularly suitable as a sealing binder which also exhibits highly and permanently plastic behaviour. In this case, the fluidity when not yet set and also the plastic behaviour when set are particularly improved by adding a fraction of up to 30 %, preferably of around 20 % bentonite to the marl. In this case it is understood that each individual value in the specified interval of 0 % to 30 % is possible.

Exemplary embodiments of the invention will be explained hereinafter with reference to the drawings. In the figures

Fig. 1	is a schematic cross-sectional view of a well according to the invention,
Fig. 2	is an enlarged view of the lower well area and
Fig. 3	is a view corresponding to Fig. 1 of a further embodiment where ground water is obtained from two water levels.

The individual figures each show a well 1 which is presently used to extract ground water. In principle, wells of the type shown can also be used for observing or for lowering ground water. In the embodiment shown in Fig. 1 the well 1 has a standpipe 2 which is hereinafter designated as inner standpipe. Adjacent to the inner stand pipe 2 is a filter pipe area 3 via which the ground water is obtained. The filter pipe area 3 has perforations whose opening width is smaller than the filter gravel of the filter gravel casing 5 arranged around the filter pipe area 3. Located inside the inner standpipe 2 is a pump 6 whose pump line 7 leads to a well head 8.

In the present case, the inner standpipe comprises a pipeline comprising a plurality of individual pipe lengths placed adjacent to one another. The filter pipe area 3 comprises an inherently separate pipe length which is connected to the pipeline. It is naturally understood that in the case of short standpipes it is also possible that the pipeline merely consists of a single piece where the filter pipe area 3 can be constructed in one piece with the standpipe. Hereinafter only the term "standpipe" is used regardless of whether this standpipe comprises one or a plurality of pipe lengths.

In the embodiments shown a spraying device 9 is associated with the filter pipe area 3 so that the filter pipe area 3

and/or the filter gravel casing 5 can be sprayed by means of said device in order to regenerate this area. The spraying device 9 is connected to a pressure line 10 for supplying the spraying device 9 with a medium to be sprayed. As can be seen in particular from Fig. 2, in the embodiment shown the spraying device 9 comprises an annular channel 11 having a plurality of nozzles 12 affixed to the filter pipe area 3. In the case of filter areas 3 having a greater length than that shown in Fig. 1, a plurality of annular channels can be provided, these being connected to the pressure line 10. In the exemplary embodiment shown the nozzles 11 are aligned parallel to the pipe axis adjacent to the wall of the filter pipe area 3. The outwardly expanding nozzle jet from the nozzle 12 thus acts on the wall of the filter pipe area 3 and loosens the filter gravel of the filter gravel casing 5 which results in regeneration. In the present case, the nozzles 12 each have a spring-loaded check valve 13 which is only indicated schematically. This avoids any penetration of filter gravel or other particles and clogging of the nozzle 11.

When only one annular channel 11 is used, the spraying device has a base plate 13 which is placed on the end of the filter pipe area 3. The spraying device 9 thus forms the lower end of the inner standpipe line. When a plurality of annular channels are used, it is understood that the lower base plate 13 is omitted. In the present case, the spraying device 9 itself together with the pressure line 10 consists of stainless steel to ensure permanent operation. The pressure line 10 is fixed to the outside of the inner standpipe 2 which is not shown in detail.

It can be seen from Figs. 1 and 3 that the pump line 7 of the pump 6 communicates with an outlet 14 at the well head 8. The outlet 14 comprises a drain pipe via which the ground water can be led off. If no ground water is led off via the outlet, which is generally the case, the ground

water is supplied for its further use via the ground water pipe 15. In the exemplary embodiment shown the pump line 7, the outlet 14 and the ground water pipe 15 are interconnected by means of a three-way valve 16. The three-way valve 16 can be used to lead off the ground water obtained before, during or after a spraying without it being necessary to dismantle the well head 8, remove the pump 6 or interrupt the ground water pipe 15.

As can be seen further from Figs. 1 and 3, the pressure line 10 is provided with an above-ground supply device 17 for supplying the medium to the spraying device 9. Gases or liquids which can also contain solid can be supplied as medium. Depending on the particular application, ozone for example for killing micro-organisms or other water treatment means for influencing the water quality can be supplied via the supply device 17. The spraying device 9 can thus fulfil a double function, namely on the one hand it can contribute to cleaning or regenerating the filter pipe area 3 and the filter gravel casing 5 and on the other hand it can contribute to influencing the quality of the drinking water.

The supply device 17 itself can be constructed to supply the medium at constant pressure. It is also possible to produce pressure surges via the supply device 17 at regular or irregular intervals. For this purpose the supply device 17 has a corresponding pump 18. Furthermore, a pressure limiter 19 is provided in the present case to avoid unintentional overpressures. The supply device 17 further has a time clock 20 in order to carry out the spraying and therefore the regeneration only over a predetermined time interval, making automatic operation possible. In this connection it is also provided that both the supply device 17 and also the outlet 14 or the three-way valve 16 are coupled to a controller 21 so that ground water can be led

off automatically from the outlet 14 for a predetermined time interval depending on the spraying.

In the present case, in connection with the automatic operation the valve 16 has a motor drive which is not shown. It is hereby possible to open the valve 16 for a predetermined time interval to lead off conveyed ground water via the outlet 14 and specifically at the beginning of spraying or at a predetermined time after the beginning of spraying. The duration of the time interval for leading off water via the outlet 14 is determined from empirical values. Alternatively it can be provided that a corresponding monitoring sensor is associated with the controller 21 which monitors the water quality. As soon as the water quality is sufficient, the valve 16 switches over again and the water is supplied to its intended usage via the ground water pipe 15.

It is naturally understood that the valve 16 can be a manually actuated valve. In this case, the controller 21 is not necessary.

In the embodiments shown it is also the case that the inner standpipe 2 is arranged in an outer standpipe 22. The outer standpipe 22 can be constructed in the same way as has been described previously in relation to the inner standpipe 2. However, no filter pipe area 3 is provided there. The outer standpipe 22 is fixedly connected to the surrounding rock mass 23. It is also the case that the inner standpipe 2 can be withdrawn from the outer standpipe 22. For this purpose it is merely necessary to dismount the well head 2 and withdrawn the pump 6. The inner stand pipe 2 which otherwise has no fixed connection to the outer standpipe 22 can then be withdrawn. The outer standpipe 22 ensures that the borehole is kept open. As can also be seen from Figs. 1 and 3, the filter pipe area 3 projects over the lower end of the outer standpipe 22 so that ground water can be

extracted via the filter pipe area of the inner stand pipe 2 unimpaired by the outer standpipe 22.

For positioning the inner standpipe 2, spacers not shown are provided on its outside to ensure a substantially central arrangement of the inner standpipe 2 in the outer stand pipe 22 although this is not clear in the figures. The radial extension of the spacers is greater than the outside diameter of the pressure line 10 so that an additional protective effect for the pressure line 10 is obtained via the spacers.

In the embodiments shown it is furthermore the case that the outer standpipe 22 is sealed with the surrounding rock mass 23 by means of a hydraulic mineral binder 24 so that the ground water is only obtained from the water-bearing layers (in Fig. 1) or A and B (in Fig. 3) in which the filter pipe area 3 is located whereas an inflow of external water from other layers is avoided. In the present case, the binder 24 is one that exhibits highly and permanently plastic behaviour after setting. In the present case, a natural-based water-solid mixture having a predominant fraction of fine-grained marl and a small fraction of about 20 % of fine-grained bentonite is used as hydraulic binder.

The embodiment shown in Fig. 3 differs from that in Fig. 1 in that the inner pipeline 2 has two filter pipe areas 3 in different levels. Here ground water is obtained from the water-bearing layers A, B. It is understood that a plurality of filter pipe areas is also possible.

The well 1 shown in Figs. 1 and 3 is regenerated by first supplying a regeneration medium, for example, water under pressure via the supply device 17. At the same time, pressure surges are produced, acting on the filter gravel casing 5 on the one hand and on the outside of the filter pipe area 3 on the other so that blockages in the pores and

capillaries of the filter gravel casing 5 and at the perforations 4 of the filter pipe area 3 are released. At the same time, the pump 6 remains in pumping mode so that the released particles are removed. Immediately after the beginning of spraying the valve 16 is set by means of the controller 21 so that the ground water contaminated as a result of the regeneration of the lower well area is removed via the outlet 14. After the end of spraying and a subsequent predetermined time interval, the valve 16 is moved into its normal position whereby the outlet 14 is closed and the access to the ground water pipe 15 is opened again.

In the embodiment according to Fig. 1 during pumping ground water is presently only obtained from level A but not from other levels.

If no satisfactory regeneration of the lower well area can be achieved by means of the spraying described previously, the inner standpipe 2 is withdrawn together with the filter pipe area 3, the spraying device 9 and the pressure line 10. For this purpose the well head 8 is first dismantled and the pump 6 withdrawn. After withdrawing the inner standpipe 2, the filter gravel casing 5 collapses into itself and can be flushed out. After cleaning the filter pipe area 3, the inner standpipe 3 can be re-inserted into the outer standpipe 22 together with the pressure line 10 of the spraying device 9. The required quantity of filter gravel is then inserted via the annular space provided between the inner and the outer standpipe which is held open by the spacers. After inserting the pump and closing the well by placing the well head thereon, the well 1 can be operated again.